Thailand's Middle-Income Trap: Firms' Technological Upgrading and Innovation and Government Policies

Patarapong Intarakumnerd

Once recognized as a high-performing newly industrializing economy, Thailand is currently in the middle-income trap. The country has remained at the middle-income level for more than 15 years. A major reason for such development is a relatively low technological learning of firms in Thailand. After a financial crisis in 1997, certain improvements transpired; for example, transnational corporations and large local firms started to invest increasingly in building rather sophisticated technological capabilities in product and process design, advanced engineering, and R&D. However, Thailand is still lacking a critical mass of innovative firms, which can pull the country out of the trap. On the government side, perpetuated ineffective science, technology, and innovation policies have been implemented for several decades.

Keywords: Thailand, Middle-Income trap, Technological learning, Technological capabilities, Science, Technology, and Innovation policy

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Patarapong Intarakumnerd, Professor, National Graduate Institute for Policy Studies (GRIPS), Tokyo, Japan. (Email): patarapong@grips.ac.jp, (Tel): (81)-3-6439-6122.

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I. Introduction

From the mid-1980s to the mid-1990s, Thailand had been recognized as a high-performing Asian newly industrializing economy (NIE); this country could be successful in industrial catching up with the West, similar to the experiences of Korea, Taiwan, Hong Kong, and Singapore. Thailand experienced double-digit growth in its gross domestic product (GDP) and diversified its economy, which comprises various agriculture and manufacturing products and thriving services, especially tourism. Nonetheless, the country faced a major economic crisis in 1997. Although the economic situation had improved within a few years afterward, the country's long-term growth rate and competitiveness as a once-rising star and labor-intensive products (*e.g.*, textile, shoes, and clothing) had declined substantially. Simultaneously, Thailand failed to climb up the technological ladder to produce additional knowledge-intensive products and services. These conditions caused growing concerns among Thai policymakers; recently, the general public believed that Thailand is nearly falling into the *middle-income trap*[1] because the country has been at the upper-middle-income level for 15 years until 2018 and still remains unable to reach the high-income economic status. The situation in Thailand is similar to those of neighboring Asian countries in Southeast Asia, such as Malaysia (see Wong 2019 on this special issue).

This paper aims to explain why Thailand is in the middle-income trap from the perspective of technological upgrading. First, the overall industrial development and the middle-income trap faced by Thailand is summarized. Second, the two important factors behind Thailand's middle-income trap are highlighted. These factors are presented as follows: 1) the lack of firms' technological upgrading and innovation and 2) the highly ineffective science, technology, and innovation (STI) policy habits.

[1] By analyzing historical income transitions, the threshold number of years for a country to be in the middle-income trap is calculated. This cut-off value is the median number of years that countries spend in the lower middle-income and in the upper middle-income groups. A threshold of **14 years** to cross the upper middle-income to high income (USD5,000 to USD11,750) was computed (Felipe *et al.* 2014)

II. Overview of Thailand's Industrial Development

Thailand was once recognized as a high-performing Asian economy. Its economic growth rate from the 1960s to the 1990s impressively exceeded 7%. A high average economic growth contributes to the increase in the well-being of Thai people in general. A steady increase in real wages in all economic sectors had occurred from 1984 to 2010. Many people were lifted out of poverty. Approximately 40% of the population has escaped poverty in only nearly one generation from 1986 to 2010 (25 years) (Jitsuchon 2014).

Thailand's industrialization can be divided into three periods as follows: import substitution (late 1950s–1970s), export promotion (1980s–mid1990s), and liberalization (late 1990s onward). The aquiculture sector contribution to the GDP had considerably reduced from 44% in 1951 to 8.7% in 2015, while the share of manufacturing increased markedly from 13% to 27.5% during the same period. In terms of export, while the role of primary products had declined relative to that of manufacturing, agriculture itself had diversified remarkably because Thailand became one of the world's top exporter of extensive primary or primary-based products, including rice, rubber, sugar, cassava, prawns, and canned pineapple. Simultaneously, manufactured exports displayed impressive growth and diversification in sectors ranging from textiles to automobiles and parts and to electronic and electrical components. For example, the export shares of electronic and automotive products have increased from 0.04 and 0.25 in 1970 to 25.20 and 6.68 in 2006, respectively (Yusuf and Nabeshima 2009). Thailand's economic status changed from low-income to upper-middle-income country since 2003. Behind this success lies prudent macroeconomic management, early adoption of export and foreign direct investment (FDI) promotion policies, investment in physical infrastructure, and expansion of school and university enrolment (World Bank 1993).

Nonetheless, several scholars, such as Kunio (1988), have strongly questioned the sustainability of Thailand's economic prosperity. This author described the Thai economy as "ersatz capitalism." In contrast to Western countries, Japan, and first-tier East Asian NIEs, the Thai economy grew by overcoming its bottlenecks with foreign technology and capital without expending serious efforts to increase its own saving and upgrade technology. This author believed that this type of

capitalism cannot constantly expand. Kunio's prediction came true when the country experienced a major economic crisis in 1997. Since then, the economic growth rates have decreased substantially to 3%–4% annually and even further down to 2%–3% on average after 2014 when the military took over the country. This growth rate has become the new normal for Thailand. The country's once rising-star and labor-intensive sectors, such as textile, garments, toys, and shoes have lost their competitive edge to low-wage countries. Concern on the middle-income trap has been spreading among Thai policymakers, scholars, and the public.

Specifically, concern is raised about the limited intensity of technology development in the industry, which has contributed to such a competitive weakness. This circumstance is reflected in several key economic indicators, especially on the growth of total factor productivity (TFP). The growth in TFP explains other reasons for a country's economic growth beyond the growth of capital, labor, and land. In addition to education and other social capital and institutional factors (*e.g.*, entrepreneurship and trust), TFP includes the progress of STI. Although Thailand's economic growth rate in the past 50 years is rather impressive, this rate has been achieved largely by using factor inputs. From 1987 to1995, the Thai economy grew at the rate of nearly 10%, whereas the TFP growth rate was only approximately 1.5% (National Economic and Social Development Board [NESDB] 2007a).

The Thai economy is rather unique in Southeast Asia because no class of indigenous big business entrepreneurs exists in the country. Even small businesses in Bangkok, especially in retailing, are mostly owned and operated by Sino-Thais (East Asian Analytical Unit 1995, p 78). According to GEM, Bangkok University, and BUSEM (2012), Thailand has a high rate of entrepreneurial activity. "Necessity-based" entrepreneurship (*i.e.*, where people become entrepreneurs because they must survive economically) is prevalent (such as in the case of street vendors), but the existence of a critical mass of "opportunity-based" entrepreneurs who seize and execute risky opportunities through innovations is uncertain. This opportunity-based entrepreneurship is typically an important characteristic of successful startups. Innovation surveys show that risk-taking attitude is rather low among Thai entrepreneurs, although this attitude has improved in recent surveys. Thai traditional wisdom emphasizes conforming to existing societal values and the ideas of elders rather than challenging them.

In terms of trust, Chinese-owned businesses tend to be built as family-affiliated corporations that allow ownership- and kinship-led rather than skill-based management. This "family-ownership-control-type business" (Suehiro 1992, p 392), which is characterized by low stock ownership diffusion and added family-related chief executive officers (CEOs), has led to business and joint investment co-operation among different companies within the same family affiliates *but to only few* co-operations among various enterprises of different families (Suehiro 1992, p 390; East Asian Analytical Unit 1995, p 78). Although many Chinese-run firms have grown into huge conglomerates that cover many business areas, the founding family still keeps the ultimate rein. Afterward, firms under the same family umbrella overlap and compete, thereby leading to intra-family conflicts. In sum, co-operation is less likely in inter-family businesses, and co-operation frequently draws family complexity and contention in the intra-family enterprises.

III. Firms' Technological Capability Development and Innovation

Behind the low TFP growth rate and loss of Thailand's industrial competitiveness is the limitation pertaining to technological upgrade and innovation at the firm level. Several studies of firms in Thailand since the 1980s have confirmed that most firms have grown without deepening their technological capabilities in the long run, and their technological learning has been very slow and passive (Bell and Scott-Kemmis 1985; Chantramonklasri 1985; Thailand Development Research Institute 2004; Dahlman and Brimble 1990; Tiralap 1990; Mukdapitak 1994; Lall 1998). According to a World Bank-commissioned study by Arnold *et al.* (2000), only a small minority of large subsidiaries of transnational corporations (TNCs), large domestic firms, and small and medium enterprises (SMEs) have R&D capability, and the majority remains struggling with an increase in their design and engineering capability. For many SMEs, the key issue is much more concerned with strengthening additional basic operational capabilities, together with craft and technician capabilities for efficient acquisition, assimilation, and incremental upgrading of fairly standard technology.

The slow technological capability development of Thai firms differs considerably from the development that characterized Japan, Korea, and Taiwan. Firms in these countries move rather rapidly from being

mere imitators to innovators. In the1960s, Japanese firms have become increasingly innovative, invested heavily in R&D, and relied minimally on importing foreign technologies (Odagiri and Goto 1993). In general, firms in Korea and Taiwan, where industrialization (beginning with import substitution) started relatively in the same period as in Thailand, are successful in increasing absorptive capacity (of foreign technology) and deepening indigenous technological capabilities in several industries (Amsden 1989; Kim 1993; Lall 1996; Hobday 1995; Kim 1997). For example, in the electronics industry, Korean and Taiwan firms climbed technological ladders by exploiting institutional mechanisms, such as providing assembly services as original equipment manufacturers (OEMs) and/or providing designs as own brand manufacturers (ODMs) to TNCs. Therefore, latecomer firms in such countries can acquire advanced technology and access demanding foreign markets (Hobday 1995).

Nonetheless, after the economic crisis in 1997, a few interesting positive changes have occurred in the industrial sectors in Thailand.

(a) Several large conglomerates, such as the CP Group and Siam Cement Group, increased their R&D activities. One large conglomerate alone invested 16millionUS$ on R&D in 1999. This development is due to the crisis have convinced the executives of these companies that long-term survival depends on deepening their technological and innovative capabilities. These companies cannot simply rely on importing off-the-shelf technologies and the knowledge necessary for simple production as they have executed previously.
(b) Several small companies recently increased their technological efforts by collaborating with university R&D groups to lead in the market or seize the most profitable market section.
(c) Recently, several subcontracting suppliers in the automobile and electronics industries were forced by their TNC customers/ partners to strengthen their efforts to modify product design and improve efficiency and be capable of absorbing the design and knowledge from foreign experts. To continue working with TNCs, several local suppliers in the automotive industry have been aiming to upgrade their production processes by introducing Industry 4.0-related technologies, such as robotics and artificial intelligence (Lee *et al.*, forthcoming, 2019).

Table 1
Percentage of R&D-performing and Innovating Firms in Thailand's Innovation Surveys

	2003	2008	2011	2014
R&D-performing firms	6.0%	2.43%	7.96%	27%
Innovating firms	5.8%	4.24%	20.73%[2]	23%

Source: Reports on R&D/Innovation Surveys 2003 and 2008 by the NSTDA and the R&D/Innovation Surveys for 2011 and 2014 by the National Science Technology and Innovation Policy Office

(d) New start-up firms (less than 50 employees) that rely on their own design, engineering, or development activities emerged. These companies are managed by entrepreneurs who acquired strong R&D backgrounds while studying or working abroad. Many of them are "fabless" companies (Intarakumnerd *et al.* 2002). However, the pool of potential entrepreneurs is relatively small because the rate of enterprise creation per population is relatively low; moreover, scientists, engineers, and managers prefer to work in public agencies or large businesses (OECD 2011).

The low level of technological and innovative capabilities and passive learning of Thai firms are reflected by R&D and innovation community surveys. Surveys were conducted by the National Science and Technology Development Agency (NSTDA) and then the National Science Technology and Innovation Policy Office. R&D surveys were conducted annually, but the innovation surveys were conducted on 2003, 2008, 2011, and 2014. The number of R&D-performing and innovating firms in the manufacturing and service sectors in 2014 were 27% and 23%, correspondingly (Table 1). This result shows moderate improvement in innovation performance of the firms in Thailand. This improvement corresponds to the positive changes after the financial crisis in 1997.

Nonetheless, Thailand's performance remains relatively poor in

[2] Like previous surveys, the 2011 survey also followed the definitions of the Oslo Manual. However, additional descriptions of the different types of innovation were provided. Therefore, surveyed firms could recognize well when they implemented innovation. This situation may explain why the figures were higher in innovating firms than in previous surveys.

Table 2
Types of Products by Global Value Chain: Year 2011

Type of firm	Types of products (% of total revenue)				
	Manufacturing arms of parent companies	Original equipment manufacturers (OEMs)	Original design manufacturers (ODMs)	Original brand manufacturers (OBMs)	Others (traders)
Thai firms	9%	20%	16%	25%	30%
TNCs/Joint ventures	21%	28%	16%	17%	18%

Source: Thailand Innovation Survey 2011, National Science Technology and Innovation Policy Office

relation to successful Asian countries. A comparison between the Thailand and Korea innovation surveys conducted in 2011–2012 demonstrates the differences in terms of their respective innovative capabilities. Companies in Thailand lag far behind companies in Korea with respect to innovation. More than 40% of firms in Korea conducted innovations against approximately 6% in Thailand. Notably, a high share of companies in Korea performed product innovations. This result might indicate that companies in Thailand are at the stage where they would rather use their resources to improve production processes than the products themselves, which, in turn, could hint toward a rather OEM-oriented economy. TNCs and joint ventures in Thailand operate at the low end of the global value chain. Most of their products (67%) are manufactured in accordance with the design specifications of parent companies or those provided by external buyers and traders. Similarly, most of Thai-owned firms' products (59%) are manufactured at the low end of the global value chain (Table 2). Simultaneously, few companies in Thailand perform product and process innovations, which, conversely, are very common in Korea. This disparity reflects the advanced innovation behavior of companies in Korea.

In terms of size, small firms tend to engage less in R&D and innovation activities than large ones, and, when the former do so, their activities tend to be less sophisticated. Conducting quality control or testing activities is quite common in Thailand because over two-thirds of the surveyed firms performed these activities in 2011. Small firms were also minimally receptive and have decreased capabilities in absorbing external knowledge and technology. In general, few firms

conduct sophisticated R&D activities. Only 10% of SMEs performed in-house R&D, whereas more than 25% of large firms did.

In terms of R&D intensity, TNCs and Thai-owned firms are quite similar. They spent only approximately 0.1% of their total sales on R&D. This percentage is relatively lower than that of firms in other Asian NIE countries. The propensity of firms for performing R&D varied across sectors. The leading sectors were science-based industries, such as the chemical and electronics sectors, and resource-based industries, such as the food and rubber sectors. In-house R&D expenditure was largely devoted to the development of new or improved products (65%), rather than processes (22%). Nearly one-fifth of manufacturing firms had achieved innovation, in comparison with only 5% of service firms.

The main barriers to innovation were the lack of qualified personnel, the high cost of innovation, and the limited access to information on technology and markets. The corresponding cost was an important obstacle to innovation for small firms. Interestingly, the main sources of information used for innovation were the entities that interact with firms on a regular basis (*i.e.*, customers, parent firms, and suppliers) and the Internet. Highly sophisticated sources of information, such as patent disclosures, public research institutions, and universities or business service providers, are minimally essential.

In terms of external collaboration, a horizontal relationship between firms in the same or related industries is considered unimportant by the surveyed firms. Co-operative consortiums among competing firms to research particular technology or products, such as those found in Japan or Taiwan, are rare in Thailand. Moreover, given the discussed weakness of intra-firm technological capabilities, innovation-centered interactions generated from such links are, therefore, limited. By contrast, firms tend to have further vertical collaboration with their customers and suppliers.

University–industry linkages (UIL) in Thailand are weak. Firms do not regard universities and public research institutes as important sources of information and knowledge. They do not collaborate intensely with local universities and public research institutes (see more details in Intarakumnerd and Schiller 2009; Intarakumnerd *et al.* 2018). They also perceive technical support from local universities and public research institutes as relatively weak. Thus, most UIL projects are limited to consulting and technical services. Advanced projects occur only in several outstanding cases. However, interesting aspects are noted when

R&D-performing and innovating firms are analyzed separately or if different industrial sectors are compared:

- R&D-performing and innovating firms have stronger UILs than non-R&D-performing and innovating firms. The former perceives universities and public research institutes as relatively important sources of knowledge and views the supports from universities and public research institutes in a positive light.
- R&D-performing and innovating firms in science-based industries, which require highly sophisticated level of science and technology (S&T) capabilities for their R&D and innovation activities (*e.g.*, petroleum/petrochemical, electrical machinery, telecommunication, computer sectors, and R&D services) have more intense collaboration with local universities and public research institutes than those in resource-based and labor-intensive industries. However, the food processing industry, a resource-based sector, also uses universities intensely as a knowledge source and for improving production processes.
- Firms that cooperate with industry are mostly locally owned. Old companies are more likely linking up with universities than very young start-ups, thus contradicting the university spin-off hypothesis that is valid for high-tech regions of industrialized countries. In Thailand, SMEs only cooperate with universities in very limited cases, especially those in science-based industries (*e.g.*, chemical and pharmaceutical sectors) because most of SMEs do not perform any technology-intensive activities, such as R&D, design, and advanced engineering. Joint innovation activities are likely to occur with large local companies in traditional sectors. Within the public research sector, universities are more important knowledge sources than government research institutes.

IV. Ineffective STI Policy

In addition to the limitation of firms' technological learning and innovation, the STI policies, especially those concerning industrial upgrading, are also largely accountable for Thailand's middle-income trap. In the past 50 years, several changes had occurred in these policies, but the main ideas did not change significantly. These policies became long-term habits. Several of them became doctrine and mantra

of successive generations of policymakers. Such policies were officially documented in successive five-year National Economic and Social Development Plans, Policy Statements of the Government delivered to the Parliament, and other national plans, such as industry master plans and S&T plans. These policy habits differ from those in Asian countries that were successful in industrial upgrading. We will highlight these policies in comparison with those in successful Asian economies.

Policy Habit # 1: R&D Promotion is the Most Important STI Policy

Many policymakers equate promotion of technology and innovation capability of the country with the promotion of R&D investment. The ratio of the gross expenditure on R&D (GERD) to the GDP is an important leading indicator used for formulating STI policy here. For example, according to the National STI Policy and Plan 2012–2021, the Thai government set a target to achieve 1% and 2% of GERD to GDP by 2016 and 2021, respectively.

Before the government of Prime Minister Thaksin Shinawatra (January 2001–September 2006), the S&T policy in Thailand had a narrow scope. It covered only four conventional functions, namely, R&D, human resource development, technology transfer, and S&T infrastructure development. This narrow scope of S&T was based on the so-called "technology-push" R&D model or "linear model of innovation," that is, the results of R&D will be readily designed and engineered to become new processes and/or products set to be sold in the market. The model used to be popular after WWI and until the 1960s but faded away in other countries. Academics and policymakers in other countries realize that the innovation process is not automatic, and the failure rate can be high. The effective management of all actors (government, private sector, funding institutes and market, and academia) that participate in all relevant functions from R&D to design, engineering, testing, and marketing and the forward and backward interactions between these functions are necessary.

Ultimately, for developing countries, R&D is typically not a *primary* source of innovation. This situation is due to firms in these countries have evolved as "learners" and not radical innovators by borrowing and improving technology that is already commercialized by innovating firms from developed countries (Amsden and Hikino 1993). Successful latecomer firms in Korea and Taiwan, before being able to produce

additional original innovations at present, developed strong capabilities for generating a "continuous incremental change" in technologies initially acquired from forerunner countries. In minimally successful late-comer firms elsewhere (including Thailand), accumulating this kind of technological capability within firms has been increasingly limited (Bell and Pavitt 1995). The World Bank's study on Thailand (Arnold *et al.* 2000) stipulates that only a small minority of large subsidiaries of TNCs, large domestic firms, and SMEs have the capability for R&D, whereas the majority still struggles with an increase in their design and engineering capability. For many SMEs, the key issue is concerned with building additional basic operational capabilities, together with craft and technician capabilities for efficient acquisition, assimilation, and incremental upgrading of fairly standard technology. Therefore, the aspects of technology absorption capacity, design activities, engineering developments, experimentation, and training and exploration of markets for new products are more important than R&D as an input for technological progress of a country such as Thailand. Government policies should be geared toward enhancing firms' capabilities in these areas. In 2015, the tax incentives provided by government agencies started to cover non-R&D innovation activities. Tax incentives offered by the Department of Revenue increased from 200% to 300% and expanded to cover firms' expenditure on licensing in foreign technology to advance their product and process innovations. The Board of Investment (BOI)'s new "merit-based" investment promotion scheme introduced in 2017 also covered non-R&D technological upgrading activities, such as product design, packaging design, advance technology training, licensing fees of intellectual property rights, collaboration with universities, and development of local suppliers (Suchinai 2017).

Policy Habit # 2: Firms Are the "Users" of STI Capabilities Generated by Universities and Public Research Institutes

Ultimately, the firms must compete internationally and not the universities and public research institutes. However, considering the influence of the linear model of innovation, the dominant orientation of policy and resource allocation for building technology development capabilities since the 1960s has been on the capabilities and resources of scientific, technological, and training institutions that were intended

to undertake technological activities "on behalf of firms." Conversely, policy measures and resource allocations designed to strengthen the technological learning, technological capabilities, and innovative activities "within firms" and the knowledge flow among firms and between firms and other actors in innovation processes are rather minimal and ineffective (Arnold *et al.* 2000, p ix).

Policy Habit # 3: Building Indigenous Technological and Innovative Capabilities Is Not a Major Economic Policy Objective

In contrast to Japan, Korea, and Taiwan, S&T elements were not part of Thailand's broader economic policies, namely, industrial, investment, trade and, to a lesser extent, education policies (Intarakumnerd *et al.* 2002). The Ministry of Science and Technology, not being considered an economic ministry until 2016, has more roles in promoting technology development than economic agencies, such as the Ministry of Industry (Arnold *et al.* 2000: vii). This imbalance is very different from the NIEs and Japan, where economic organizations, such as the Ministry of International Trade and Industry of Japan (Johnson 1982), the Economic Development Board (EDB) of Singapore (Wong 1999), the Economic Planning Board of Korea (Chang 1997), have valuable roles in the array of policy and institutional support for industrial technology development.

Trade policy, for which tariff is the most important instrument in Thailand, was not used strategically to promote technological learning similar to NIEs (Amsden 1989; Chang 1994; Lall 1996). Alternatively, trade policy was considerably influenced by macroeconomic policies, such as reducing domestic demand for imports during a balance of payment deficit. The Ministry of Finance, a dominant agency that controlled the policy, had limited knowledge or experience of industry and industrial restructuring (Lauridsen 2002). The industrial policy of Thailand did not focus on developing indigenous technological capability as an integral factor in industrialization (Sripaipan, Vanichseni, and Mukdapitak, 1999, p 37). In 2016, the Thailand 4.0 Plan was introduced. This plan aims to change the country into a value-based and innovation-driven economy by emphasizing the promotion of technology, creativity, and innovation in focused industries. Subsequently, the Law on National Competitive Enhancement for Targeted Industries was enacted. This Act seeks to promote an

investment that is consistent with Thailand 4.0. Incentives are provided for supporting projects of the targeted industries. Notably, in addition to tax incentives, the Fund for Enhancement of Competitiveness for Targeted Industries was established with the government seed money of US$ 285 million for investment projects engaged in R&D or human resource development in specific areas.

Nonetheless, except the automotive industry, no reciprocal performance-based criteria (*e.g.*, export and local value-added and technological upgrading targets) were set for providing state incentives, similar to those found in Korea and Taiwan (Amsden 1989, 2001; Amsden and Chu 2003). For example, investment promotion privileges were provided once approved.

The National Research and Innovation Policy Council chaired by the Prime Minister was established in 2016. The Council aims is to integrate previously separate research policy with STI policy, implant STI issues to broad economic policies, and enhance cross-ministry coordination. Members of this council comprise not only the Minister of Science and Technology but also counterparts from key economic ministries. The National Research Council of Thailand under the Prime Minister Office and the National Science Technology and Innovation Policy Office under the Ministry of Science and Technology work together as a joint secretariat. The evaluation of this council in terms of achieving its objective might be too early. However, previous supra-ministerial committees and councils failed to achieve their goals because the Prime Minister himself did not really preside the meeting, the meetings were infrequent, and mechanisms for executing, monitoring, and evaluating resolutions (once approved by such committees) were lacking.

Policy Habit # 4: Selective Policies for Particular Sectors or Clusters as Market Distortions

Economic policies were heavily influenced by the World Bank's "market-friendly" approach to industrialization. Moreover, given the neo-classical economics inclination of leading Thai technocrats, such policies were limited to the so-called "functional" intervention, such as promoting infrastructure building, general education, and export push in general. Virtually no selective policy measures, such as special credit allocation and tariff protection, targeted particular industries or clusters because these measures were considered market distortion by

mainstream economists. An exception was the automobile industry. Despite relatively liberal policy on such industry, the Thai government successively raised its local content requirements for automobile manufacturers who invest in Thailand.

A major change in policy came under the Thaksin government (2001–2006). For the first time, the Thai government had serious "selective" policies that address specific sectors and clusters. The government declared five strategic sectors, which Thailand should pursue: automotive, food, tourism, fashion, and software. Clear visions were directed to the five sectors, namely, Kitchen of the World (food cluster), Detroit of Asia (automotive cluster), Asia Tropical Fashion, World Graphic Design and Animation Center (software cluster), and Asia Tourism Capital. The cluster concept was introduced and went considerably beyond the linear model of innovation because the concept focused on interactive and collective learning among firms and between firms and other actors in close geographical proximity. Thailand was divided into 19 geographical areas. Each area had to plan and implement its own cluster strategy by focusing on a few strategic products or services. Every area was supervised by the so-called "CEO Governors," who were given authority by the central government to act similarly to provincial CEOs. At the local level, the cluster concept was applied to increase the capacity of grassroots economy for "community-based clusters," especially to help the "One Tambon One Product' " initiative. Nonetheless, the actual implementation of the concept had mixed results given the misinterpretation of the concept of policy practitioners at the implementation level, policy discontinuity, inadequate trust and participation of concerned actors, and lack of champions in the private sector in several cases (Intarakumnerd 2006). Furthermore, the Thaksin government did not sufficiently focus on long-term industrial upgrading beyond short-term and politically-branded schemes. For example, the said regime scraped the most ambitious upgrading plan, that is, the industrial restructuring project (IRP), which was initiated by the previous government, and went through extensive consultation processes with the private sector. The IRP aimed to upgrade 13 sectors with 8 sets of measures that range from equipment modernization to labor skills and product design (Doner 2009).

Since 2015, the BOI's "Super Cluster" incentive scheme was introduced to upgrade the existing five industries and encourage the

emergence of five new industries for the future development of Thailand. The following two new cluster-like mega projects were implemented: the Eastern Economic Corridor (EEC) and Food Innopolis. The EEC consists of three Eastern provinces (Rayong, Chonburi, and Chachoengsao) with a combined area of 13,285 square kilometers. The EEC will invest US$ 43 billion during the next five years, mostly through FDIs. Moreover, the EEC is intended to accommodate investments in 10 targeted industries that are important for Thailand's future. These industries are next-generation cars, smart electronics, affluent medical and wellness tourism, agriculture and biotechnology, food, robotics for industry, logistics and aviation, biofuels and biochemicals, digital services, and medical services. Private enterprises that invest in the EEC will receive a super incentive promotion package, which exceeds the current BOI incentives, including very preferable corporate and personal income tax privileges, long-term land lease for investors, a fast-tracked environmental impact assessment, and using foreign currencies in trade directly without having to exchange them into Thai Baht.

Food Innopolis is located at the Thailand Science Park under the NSTDA. This project aims to position Thailand as a global food innovation hub in the international food industry. The expected availability of resources for Food Innopolis include 3,000 researchers, 10,000 students in Food Science and Technology, 9,000 food factories, 150 food research laboratories, 20 pilot plants, and 70 universities. Tax-based incentives include the exemption of corporate income tax for up to 8 years, with an additional 50% reduction for 5 years, and the exemption of import duty on machinery. Non-tax incentives include the permission to own land and facilitation of visas and work permits. However, whether the two initiatives will be successful or not depends on implementation, which is typically problematic in Thailand given the lack of long-term commitment and coordination between concerned agencies.

Given the general scarcity and late introduction of selective policies, few institutions were founded to support the development of indigenous technological and innovative capabilities of firms in specific sectors. Most research institutes in the country can be described as "jacks of all trade but masters of none." They have too many missions, including assisting industry, building S&T manpower, educating the general public on S&T, and helping disadvantaged groups of society. They frequently cover extensive technologies without specific targets

for particular industries, and their industry linkages are rather weak. Furthermore, sectoral promotion institutes under the Ministry of Industry, such as the Thai Textile Institute, Thailand Automotive Institute, and National Food Institute, are preoccupied with their own financial survival given a short-sighted policy design, which requires these institutes to become financially independent after being established as public organizations for 5 years. Consequently, such institutes must rely on short-term and money-making activities, such as training to generate quick income at the expense of activities that promote long-term capability development of firms in the sector. The situation in Thailand differs considerably from countries like Taiwan and Korea where many government research institutes with clear-cut missions are dedicated to strengthening the technological capabilities of firms in particular sectors and sub-sectors or even for specific products.

Policy Habit # 5: TNCs Should Be Left Alone

An institutionalized belief among policymakers is that the main target of government policies should be Thai-owned firms, especially SMEs. Beyond providing tax incentives to attract FDI to bring in foreign exchanges and generate employment, TNCs should be left alone. This notion is due to policy makers assume that a) TNCs are footloose because they can leave Thailand to invest in other countries as they want; b) they keep high-value creation and value-added activities, such as R&D and product design at home; and c) all important decisions will be made at the headquarters of TNCs, and policymakers in host countries only slightly influence such decisions. These assumptions are less true these days. In contrast to portfolio investment, FDI is much more difficult to move. Local conditions (*e.g.*, availability of knowledgeable workers and skilled labor, capabilities of local suppliers, size of the local market, sophistication of local demand, and working environment) vary among countries and are difficult to imitate. Moreover, the world's largest TNCs are engaging increasingly in R&D and innovative activities outside their home countries. Moreover, TNCs are currently setting up R&D facilities outside developed countries that exceed adaptation for local markets; such developments occur increasingly in several developing countries. The R&D of TNCs' affiliates target global markets and are integrated into the core innovation efforts of TNCs (Patel and Pavitt 2000). Between 1994 and 2002, the

developing-country share of all overseas R&D by American TNCs has increased from 7.5% to 13%. For example, foreign-owned R&D laboratories in China has reached approximately 700 (UNCTAD 2005).

Furthermore, several recent studies (Ariffin and Bell 1997; Marin and Bell 2006; and Hobday and Rush 2007) have emphasized that subsidiaries of TNCs in several countries, including the electronics industry in Thailand, have more autonomy in decision-making than in the perceived conventional wisdom. If correctly formulated and implemented, then the policies of host countries can influence TNCs to invest in technologically sophisticated activities and generate spillover effects on local economies. Similar to Thailand, Singapore is another country where FDI has been very much encouraged. However, Singapore has specific government measures in generating spillover effects from FDI in terms of developing local technological capabilities. For example, in the 1970s, the Local Industry Upgrading Program implemented by Singapore's EDB specifically aimed to exploit TNCs' knowledgeable and experienced engineers to train employees of local firms in developing skills that were considered "critical" for technologically upgrading high-priority industrial sectors.

However, no such explicit and pro-active link exists between promoting FDI and upgrading the local technological capability in Thailand partially due to conventional wisdom on the roles of TNCs. Until 2004, the BOI launched the "Skill, Technology and Innovation" incentive for firms that invest in R&D, employ university graduates in S&T, and train their personnel and those of suppliers. Despite this initiative, the number of projects approved under this scheme has been relatively low, and the incentive for training suppliers' employees, the most deliberate attempt to generate spillover effects from FDI, was abolished (Chokdee Kaewsang, Deputy Director General, Board of Investment, personal communication, July 10, 2007). Hopefully, the new BOI merit-based incentive scheme introduced in 2017, as mentioned previously, can result in close knowledge-intensive collaboration between TNCs and local firms. The BOI has been weak in terms of monitoring and evaluating its granted projects in the past, and assessing "merit-based" projects, which require high organizational capability and dedication, has been a tall order for the BOI.

Policy Habit # 6: Government Grants and Direct Subsidies to Promote Firms' Technology Learning Should Be Constrained, if not Prohibited.

Advantages and disadvantages are inherent in the different forms of incentives, including tax concessions, loans, and grants. Tax incentives have the benefit of being non-discriminatory, that is, open to all firms that satisfy the stated criteria and administration is relatively simple. By contrast, grants are generally more effective for promoting focal activities prioritized by the government; in contrast to tax incentives, grants are less likely to subsidize activity that will have occurred in any case (Turpin *et al.* 2002).

In Japan, the government aimed to create "intellectual clusters," that is, regional-based clusters of universities, public R&D institutions, relevant institutes, and knowledge-intensive core companies. The central government provided a five-year financial subsidy to the cluster plans that were initiated by local governments together with local universities and firms and that subsequently passed the selection process. The goal was to foster interaction between the original technological seeds of the public research organizations and universities and the business requirements of regional companies to create a chain of technological innovations and new industries (MEXT 2002). In other Asian newly industrializing countries, such as Taiwan, Singapore, and Malaysia, grants were used effectively to promote "specific" activities (see more detailed discussion on Intarakumnerd and Wonglimpiyarat 2012).

By contrast, grant schemes in Thailand to promote specific or targeted activities that aim at enhancing technological learning of firms were rather limited. This situation is due to the aforementioned dominance of the notion of market distortion and the obstructing and rigid government regulations that emerged out of the fear of corruption and cronyism. Therefore, Thailand is missing opportunities to use an effective and targeted policy tool and must rely only on tax incentives, a blunt but easy-to-handle instrument.

Policy Habit # 7: Increasing the Number of Graduates at the Post-Graduate Level Is the Most Critical S&T Human Resource Development Issue

Policymakers, especially those who came from scientific disciplines at universities, have strongly believed that the most critical issue in S&T human resource development is the considerable increase in

the numbers of master's degree and Ph.D. graduates. This perception may be true for other reasons, such as teaching and basic research at universities and public research institutes, but several studies (TDRI 2004; Chalamwong 2007; NESDB 2007b) have confirmed that firms, local and foreign, in Thailand, do not considerably require graduates at the postgraduate level. Alternatively, their main concern is on the quantity of "qualified" bachelor-degree and vocational-certificate holders. Production-based firms and those conducting R&D basically require only bachelor degrees.

An interesting example is Toyota Motor, which recently started to perform design and development work in Thailand by setting up the Technical Center of Toyota Motor Asia Pacific Engineering & Manufacturing (TMAP-EM) in August 2003 at Samutprakarn Province. The Centre focuses on material development, design, and engineering to fit local requirements and test vehicles and their parts. The main difference from their production subsidiaries is that the Centre employs engineers more than technicians. Notably, more than 90% of engineers are bachelor-degree holders. Less than 10% are master's degree graduates, and only two employees have Ph.Ds. Executives of the Centre believe that bachelor-degree holders are sufficiently qualified to conduct development work at their organization, and increasing the number of postgraduate engineers in the future is unnecessary. Furthermore, engineers, regardless of educational background, must perform the same tasks and be trained in-house locally and in Japan for 1½ years. The Centre executives believe that, despite their satisfactory engineering knowledge, Thai engineers lack language proficiency, creativity, and group discussion ability; these skills are indispensable qualifications for research engineers.

Overemphasis on university postgraduate level comes at the expense of others. Thus, the quality of vocational education has been largely neglected by policymakers. As an industrializing latecomer, Thailand has a window of opportunity to exploit and upgrade technologies already developed by forerunner countries. To exploit such an opportunity, qualified engineers and technicians at the shop-floor level are necessary inputs for firms' technological absorption capacity and "incremental" innovation at the time of technological catching up. Although the Vocational Education Act and relevant laws exist, the lack of focus and the negative societal value toward vocational education deter the sufficient accumulation of vocational students

and technicians in the manufacturing sector. Vocational students and graduates are perceived as inferior human resources relative to students and graduates in general studies. This notion is different from that in Japan, Taiwan, and Korea, where the importance of vocational education has been highly regarded by their governments and viewed positively by societies, especially during their technological catching-up period when innovations were mostly incremental and emerging from factories' shop floors. "Project-execution" capabilities are important for latecomer firms to enter new industries (Amsden and Hikino 1993).

Politics of STI Policies

Why were the aforementioned seven habits so persistent in Thailand? An important answer lies in the perceptions of Thai policymakers. Two groups of Thai policymakers dominate STI and industrial development policies. The first group is the neoclassical economists-cum-bureaucrats; they are called "technocrats" in key economic ministries, who strongly oppose state intervention (especially selective and vertical industrial upgrading policies). The emergence and empowerment of technocrats were very much shaped by the sociopolitical circumstances in Thailand. Technocrats gained authority in policymaking during long-term successive military and semi-democratic regimes. The trend started with the military coup by Field Marshal Sarit Thanarat in 1957. Several macroeconomic agencies, such as the Budget Bureau, Office of the Fiscal Policy, BOI, and NESDB were dominated by technocrats (mostly graduates from top universities' mainstream economic departments in the United States and the United Kingdom) and were established shortly after (Doner 2009). Together with military generals, technocrats dominated policymaking and implementing processes during the governments of Field Marshals Sarit and Tanom in 1958–1973. Then, successively elected governments were too short-lived to initiate any long-lasting policies that differed from those of the technocrats. The military returned to power again in 1976, and the technocrats enjoyed another heyday during General Prem's administration (1980–1988). The subsequently elected governments were also short-lived, although the influence of technocrats diminished. The 1997 Constitution empowered elected governments and brought the Thaksin administration into power with an overwhelming majority in the parliament. As noted, the Thaksin regime initiated several policies, which were clearly different

from those of the technocrats. The two military coups in 2006 and 2014 were attempts of the establishment (including the technocrats) to regain authority in the policymaking process (see more detailed discussion on the rise and fall of the Thai technocrats in Phongpaichit and Baker 2014 and Kanchoochat 2016).

Another powerful group is the scientists-cum-policymakers who were in charge of making science and technology policies. Many of them were well-known university professors and executives who later became administrators of national-level public research institutes and funding agencies. These policymakers had amicable relationships with the economic technocrats and also gained authority during military and semi-democratic regimes. They strongly believed in the linear model of innovation and considerably focused on science-push policies that emphasize R&D and S&T human resource development. This situation differs from that in Japan and in successful East Asian NIEs, such as Korea and Taiwan, where the policymaking process is typically controlled by engineering and economic development "technocrats" who believe in the importance of industrial and technology upgrades "within" firms (Amsden 1989; Johnson 1992; Lauridsen 1999, 2008).

V. Conclusion

The competitiveness of a country is not an extensive phenomenon. Such competitiveness requires continuous upgrading and, at times, major transformation. Factors that previously underpinned competitiveness may become the ones that reduce competitiveness in the future. Therefore, the ability of a country to learn to create new factors is crucial for maintaining its position in global competition. Thailand was once recognized as a high-performing NIE. The country could have been successful in industrial catching-up with the West, similar to the accomplishments of Korea, Taiwan, Hong Kong, and Singapore. From 2014, the new normal growth rate in Thailand has been only approximately 2%–3% annually. The middle-income trap became a major concern among Thailand's policymakers. A major reason for this concern is the relatively low technological learning of firms in Thailand, for TNCs and Thai-owned firms, in the past 40 years of the country's industrialization. Nonetheless, after the financial crisis in 1997, certain improvements were implemented; for example, TNCs and large local firms started to invest more in building up than in

sophisticated technological capabilities in product and process design, advanced engineering, and R&D. This development is demonstrated by an increase in the number of firms that perform R&D and innovation in recent innovation surveys. Nonetheless, these improvements were lopsided. Most firms, especially SMEs, remained relatively weak. If Thailand aimed to overcome the middle-income trap, then this country requires many additional innovative firms as drivers toward a knowledge-intensive and competitive economy.

On the government side, the seven STI policy habits are detrimental for the survival, let alone the prosperity, of Thailand in the learning economy. Thus, breaking away from these habits and thinking alternatively are crucial. The enhancement of firms' technological and innovative capabilities should be the center of STI policies. Furthermore, policies should aim at strengthening firms' innovative capabilities beyond only R&D. Production, engineering, design, branding, and other approaches required to realize innovation should be considered. Additional targeted and differentiated policy measures for various industrial sectors, geographical clusters, and even products should be designed and implemented. Technological upgrade and innovation of firms should be a major objective of economic policies in terms of investment and trade promotion, industrial development, and education. Policies to leverage TNCs in terms of technology transfer and enhance the capabilities of local firms should be thoroughly examined and applied. Vocational education should be strengthened, and policy instruments beyond tax incentives should be allowed if appropriate and effective. All these policy changes required transforming the mindsets of policymakers and perhaps broad political changes, which minimized the influences of neoclassical economists-cum-technocrats and scientists who have dominated Thailand's mainstream economic development and STI policies for several decades.

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